

The development of a personal dust monitor for coal mines

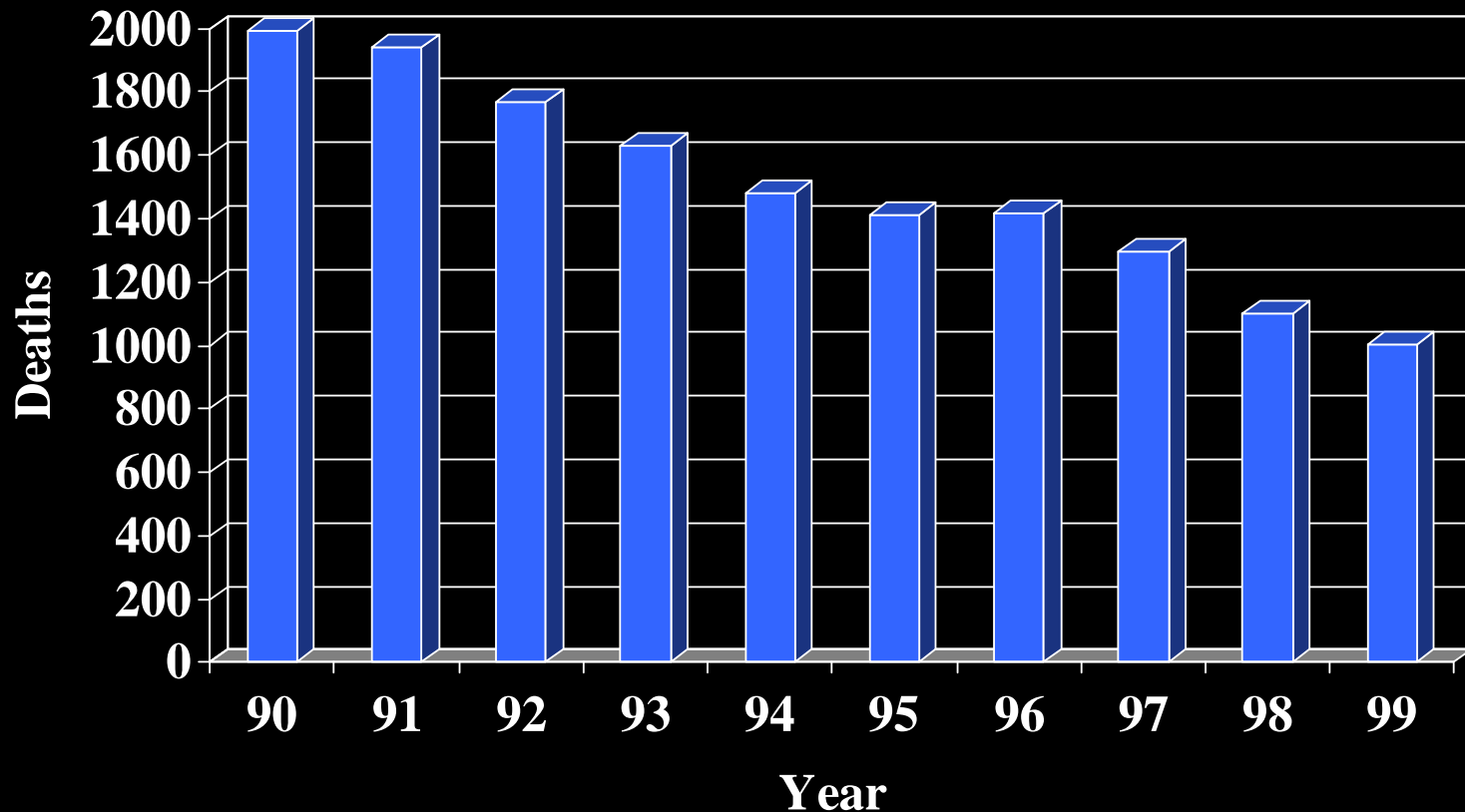
Direct Reading Exposure Assessment
Methods Workshop

Washington, DC
November 13, 2008

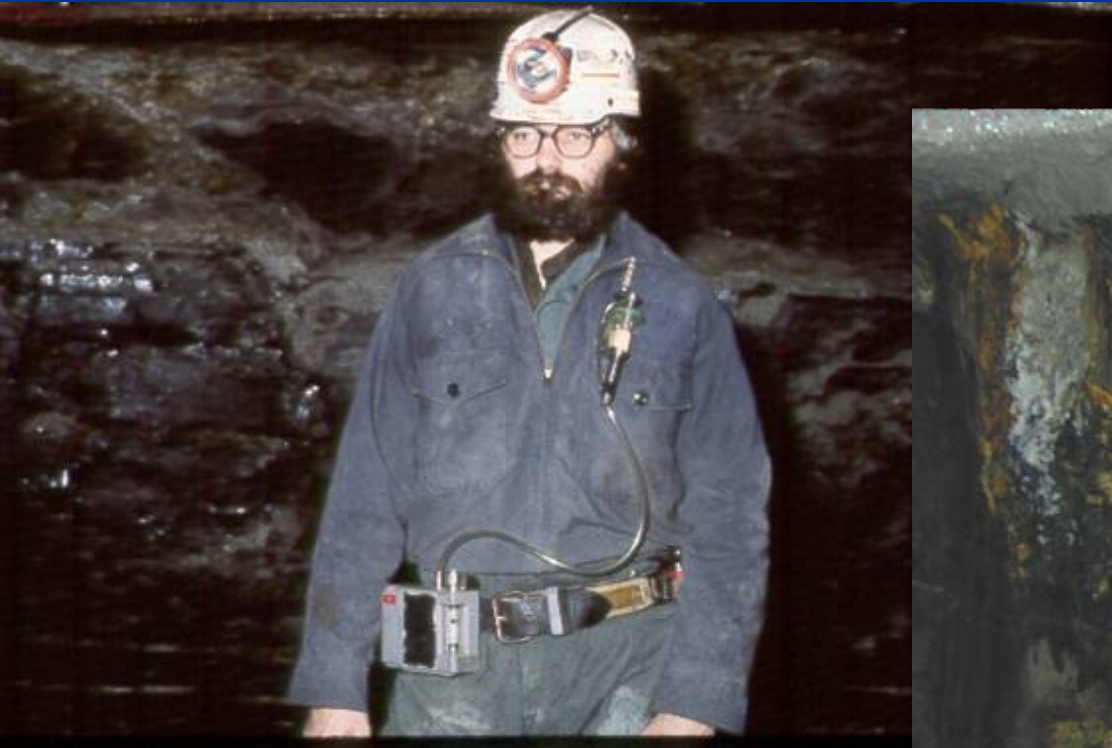
Outline

- Spoke on the worker aspects this am
- This talk focuses of the thought process of how to compare direct reading personal aerosol monitors with TWA
- Approaches to assess personal aerosol direct reading monitors
 - Laboratory
 - Field

Number of Deaths Attributed to Coal Workers' Pneumoconiosis



U. S. Coal Mine Dust Sampling



Little has changed in the last 30 years.

Direct Reading Exposure Assessment Needs

- Under recommendation of Secretary of Labor and the 1995 Federal Advisory Committee on the Elimination of Pneumoconiosis among Coal Mine Workers, NIOSH mandated to improve personal dust monitoring instruments to **provide timely data output to miners**
- U. S. miners interested in **better technology** for coal mine dust sampling for the past 20 - 30 years
- In consultation with labor, industry, and government, NIOSH contracted with R&P for the development of new **mass based** monitoring technology for mining

Direct reading dust monitors have been needed for a long time



1975



1978



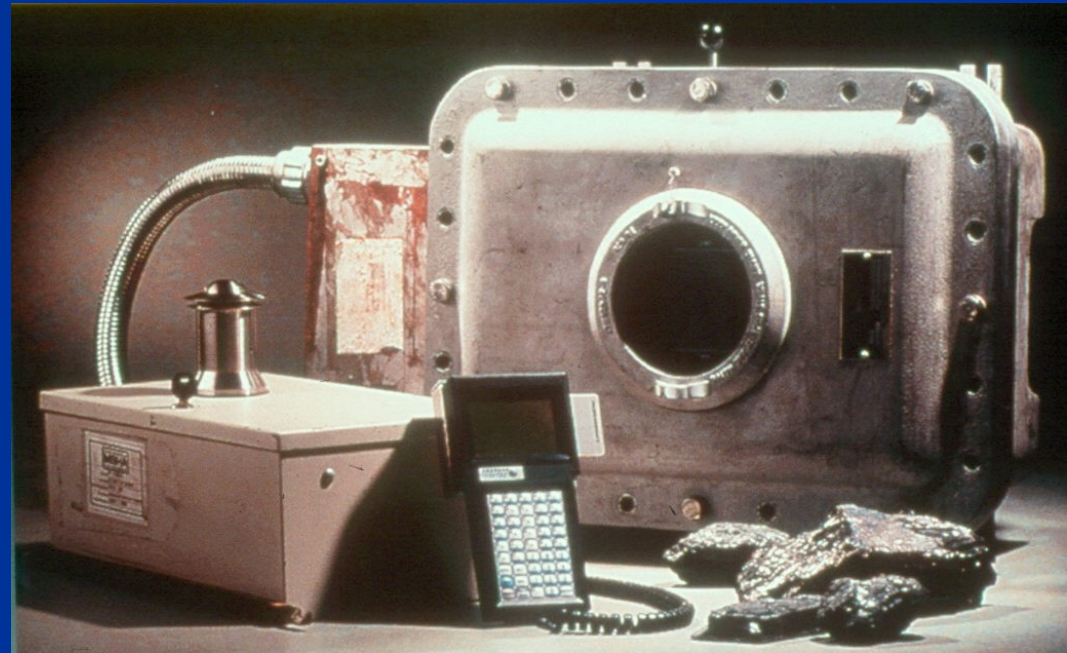
1984



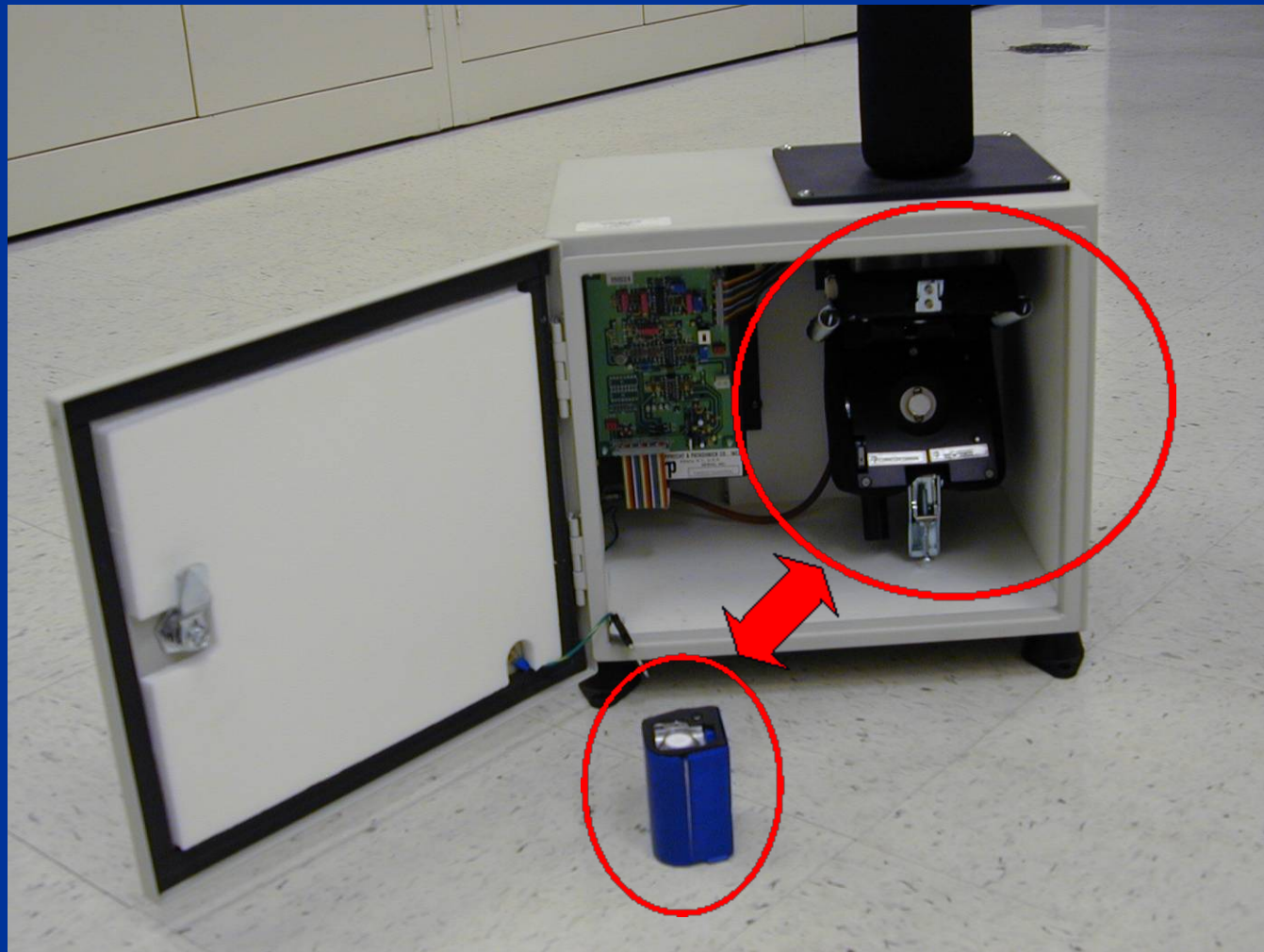
1990's

Decision by MSHA and BOM in mid-1990's to develop a mass based sensor

- Initial approach used existing fixed site environmental monitor
- Mount on mining machine much like a methane monitor
- 4 cu ft box weighing 160 lbs.
- Relied on area measurements, no data on personal exposure and not reliable

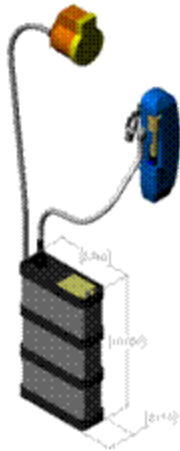


Enabling technology

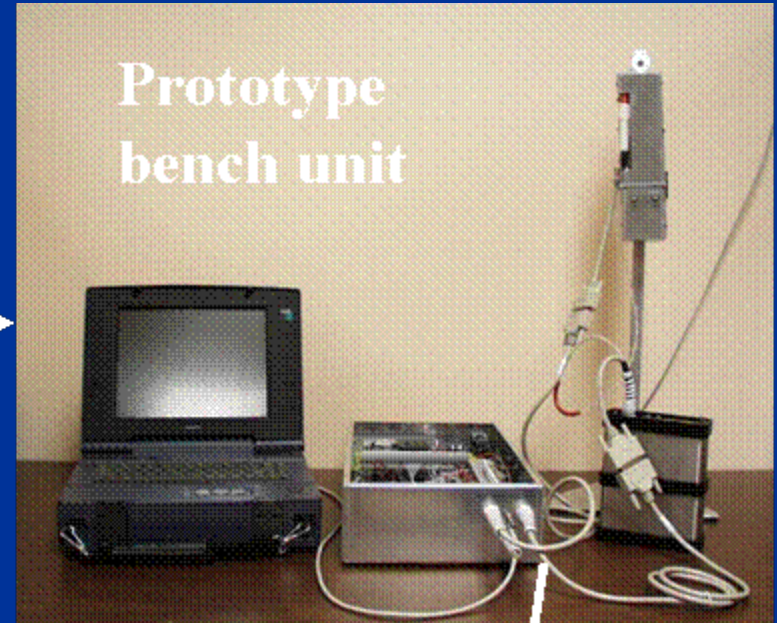


Evolution of PDM Technology

**Initial
PMD-2
concept**



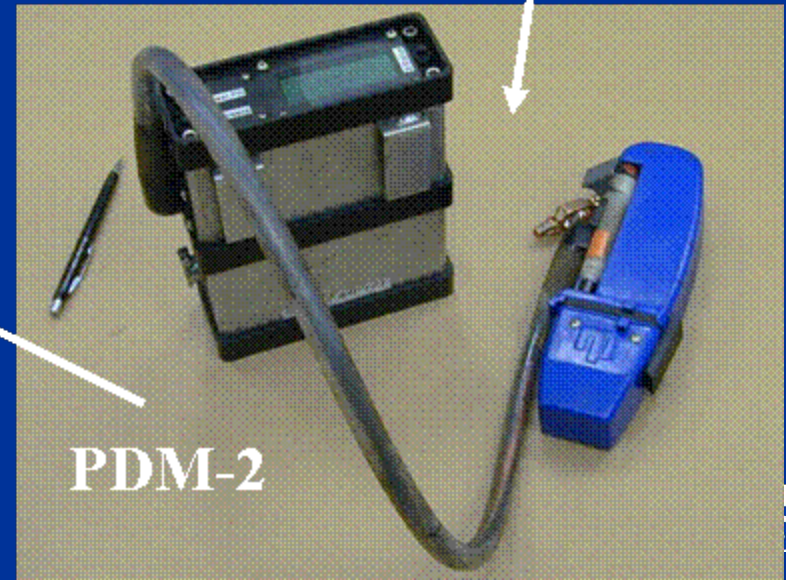
**Prototype
bench unit**



PDM-1



PDM-2

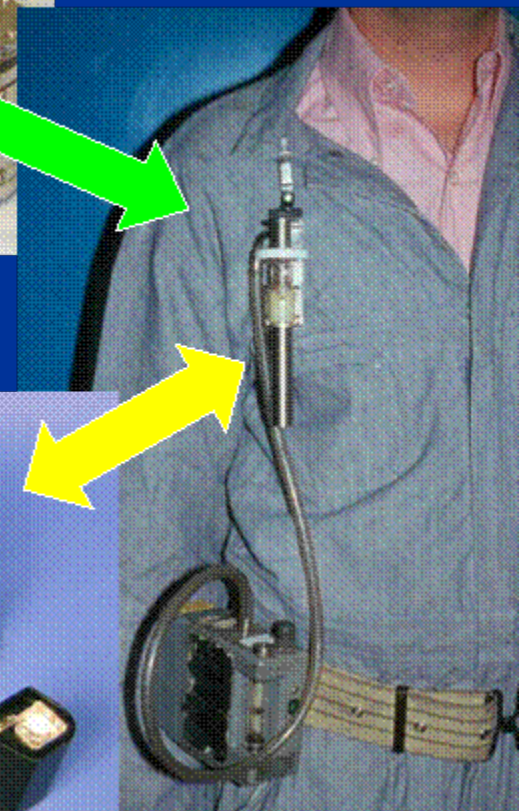
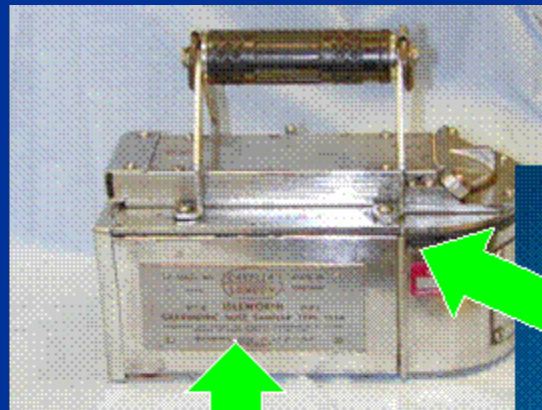


PDM Design Goals

- Equivalent to or better than the current sampler
- Provide accurate EOS reading for:
 - Mass
 - Cyclone bias – kept low
- Include cyclone with low bias relative to the MRE and ISO respirable dust convention
- Compliance with MSHA intrinsic safety requirements for both sampler and cap lamp

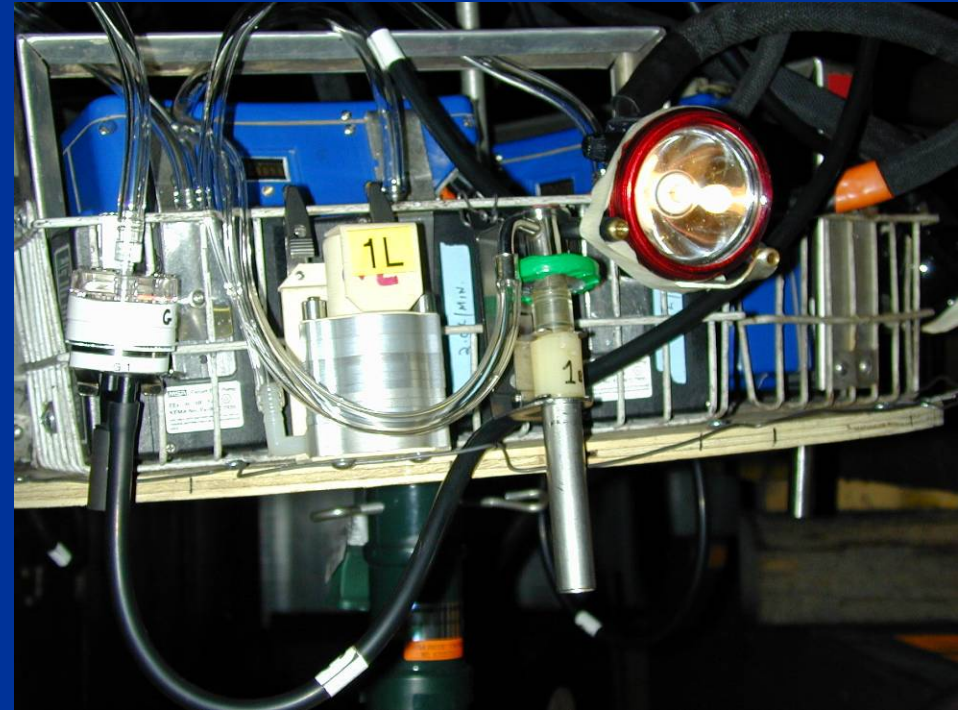
Equivalency testing

- U. S. law uses MRE equivalency
- Compare PDM directly to MRE
- Use caution when comparing between samplers -- compounds error
- Reference samplers obsolete
- Used personal impactors as reference.



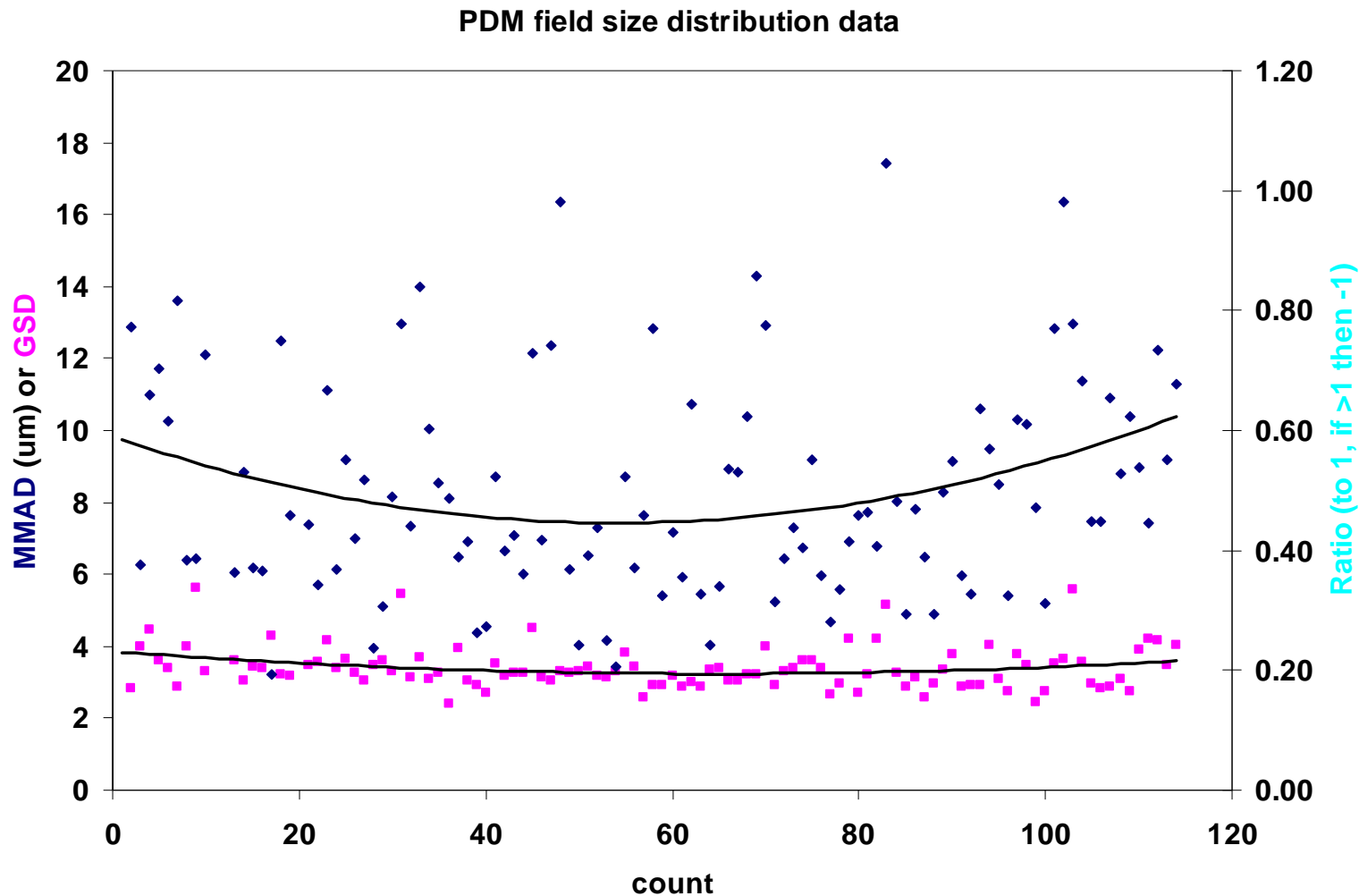
Is the mass measurement correct

- Use the best weighing procedures – QC
- Minimize variables
 - Inlet loss
 - Transport loss
 - Identical size fractionation
- Direct comparison best

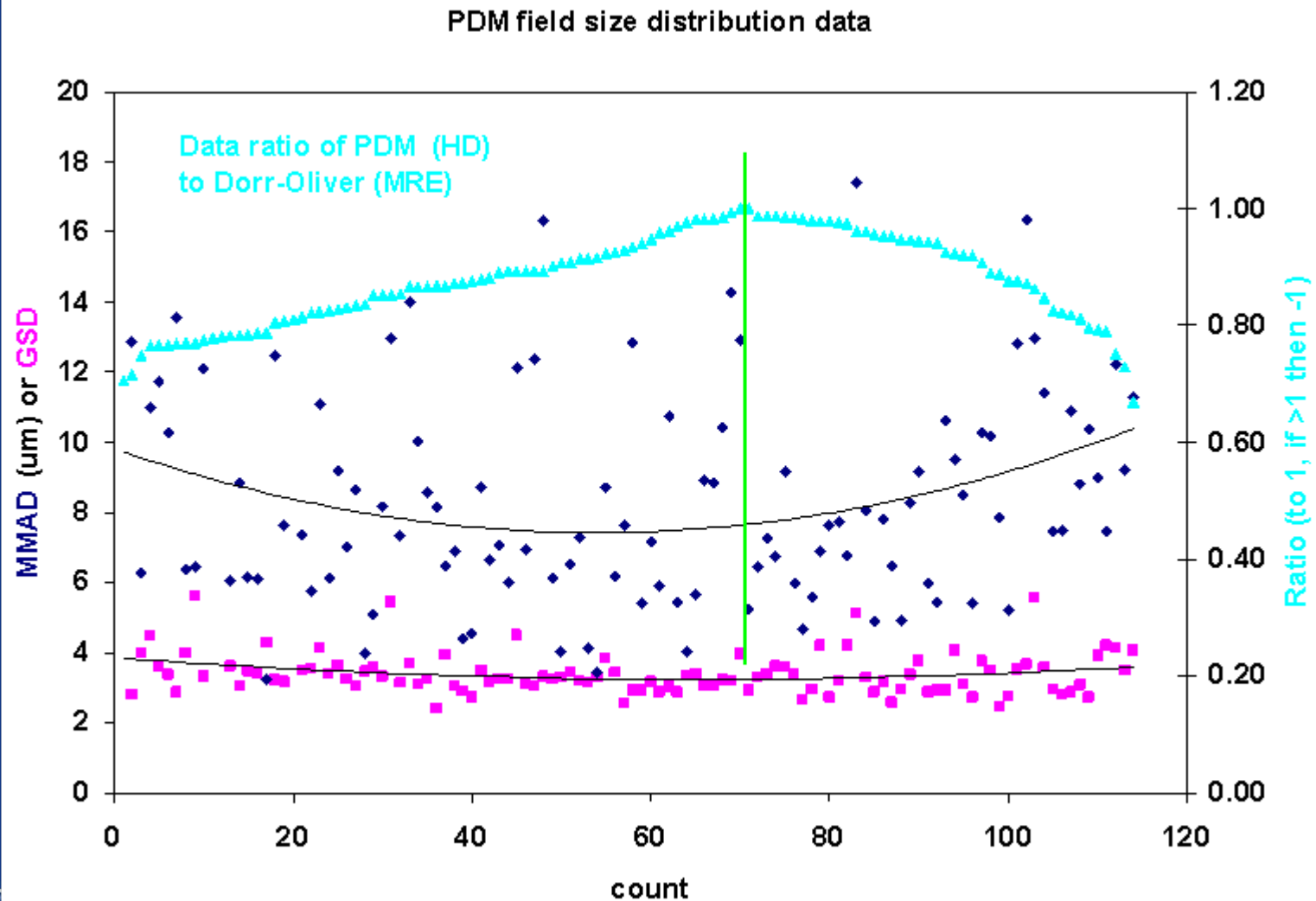


NIOSH RI 9663

Why can't we directly compare instruments in the lab?



Why can't we directly compare instruments in the lab?

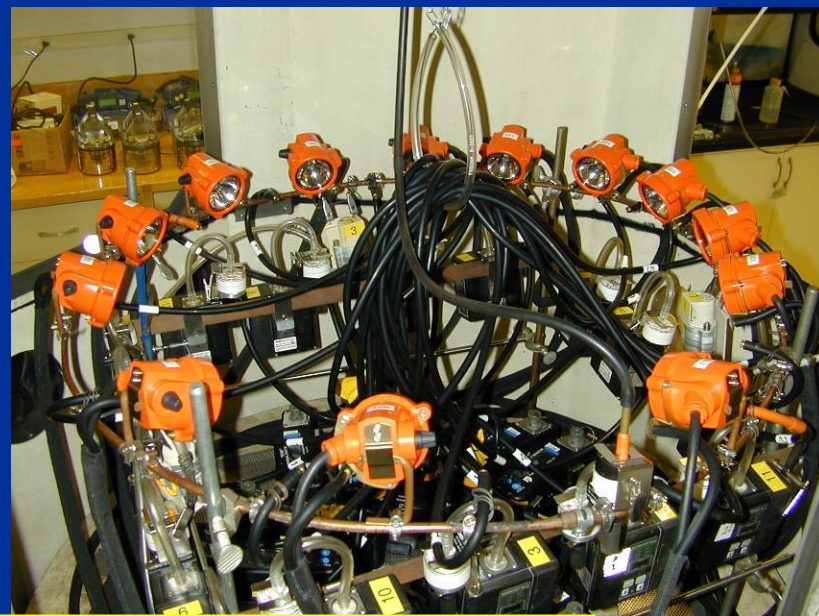


Break problem into testable hypothesis

- Direct mass to mass comparison – Does mass comparison meet recognized criterion?
- Direct determination of size selective bias. Is bias less than or equal to existing method?
- If both hypothesis are true, then direct field comparison of two methods over a wide range of aerosol size and type should be true.
- Confirm laboratory results with representative field sample

Results of Accuracy Criteria Testing for Mass Measurement

- Side by side triplicate reference versus PDM with identical inlets
- Variables
 - 3 coal types/ 3 size distributions
 - 50% RH, 22° C
- RI 9663
<http://www.cdc.gov/niosh/mining/pubs/pubreference/outputid114.htm>



Coal type	Unit serial				Confidence Limits
	number	Bias	RSD x/r	accuracy	Upper 95%
Overall	101	-0.04	0.06	12.50	15.10
	102	-0.08	0.06	15.80	17.70
	104	-0.05	0.05	11.30	12.90
	105	-0.12	0.06	20.00	21.90

Cyclone comparison testing

- Compare results of impactor defined respirable mass fraction to triplicate cyclone collected mass fraction
- Calculate ratio and test for significance by coal/size type and overall.

(MRE) Dorr Oliver /ISO	1.25
Higgins Dewell/ISO	1.15
(MRE)Dorr Oliver/ MRE	1.11
Higgins Dewell/ MRE	1.02

Laboratory Conclusions

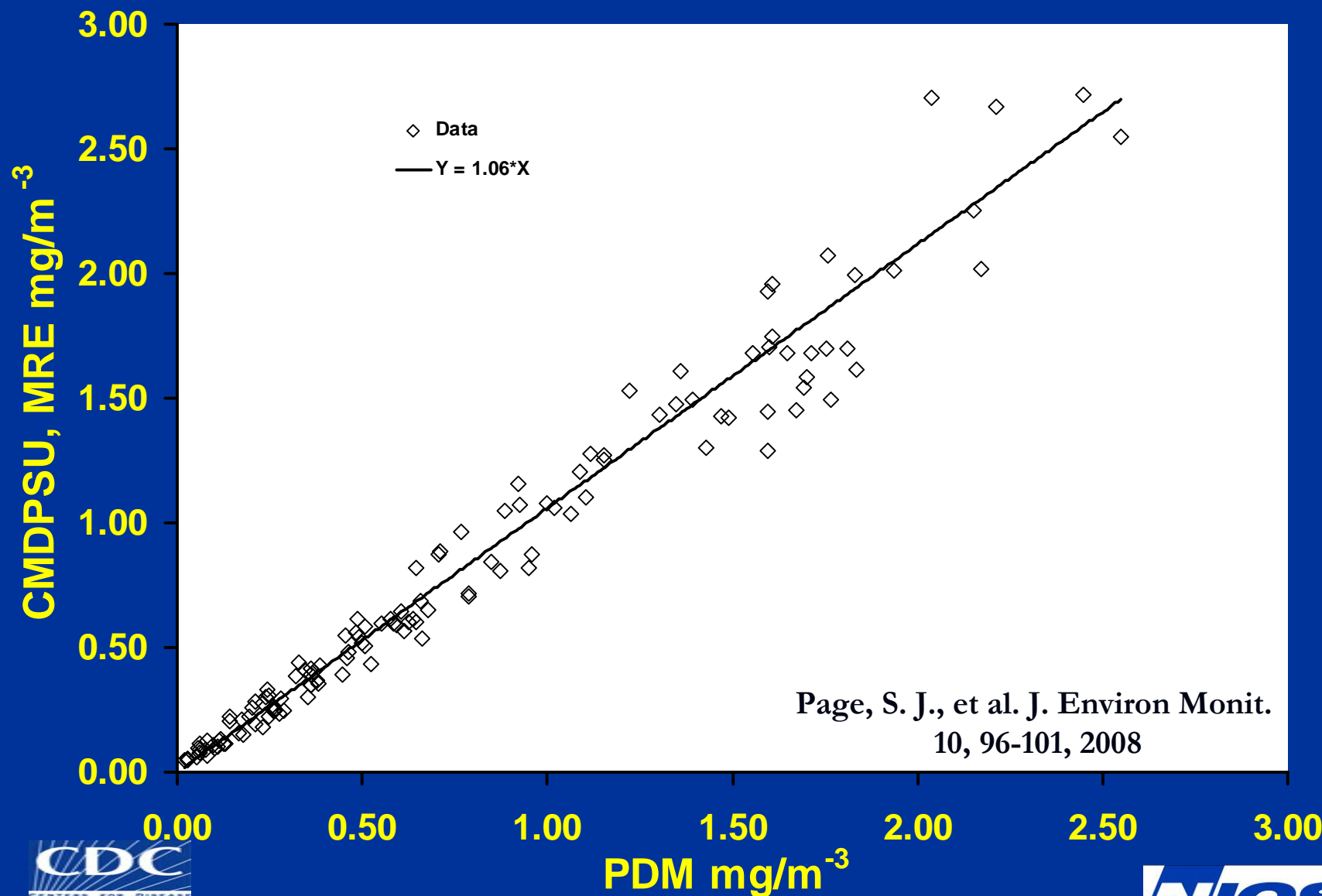
- Mass measurement by PDM meets NIOSH accuracy criteria – for an individual observation, the method gives a result that is within $\pm 25\%$ with a probability of 0.95
- And, the individual result falls within an upper or lower confidence limit of 95%
- The bias of the HD cyclone is less than the DO cyclone
- Therefore, PDM is equal to or better than existing method.

Field testing apparatus

- Chamber type sampler to minimize spatial variability
- Purpose to compare instruments
- Used central dust inlet to
 - PDM
 - Personal sampler 2 lpm
 - Personal sampler 1.7 lpm
 - Marple impactor



Field Equivalence to reference method



Conclusions

- Direct lab comparison of instruments depends on reference aerosol
- For development purposes, break problem into testable hypothesis
 - Mass
 - Size selective bias
- If end use dictates -- field test to confirm

Acknowledgements

- Joint Health and Safety Committee of the Bituminous Coal Operators and United Mine Workers,
- National Mining Association
- MSHA
- Individual mine managements
- The miners
- Thermo Fisher Scientific and formerly Rupprecht and Patashnick
- Pittsburgh Research Laboratory staff

Contact information– 412-386-6689

jvolkwein@cdc.gov

DISCLAIMER: The findings and conclusion in this presentation have not been formally disseminated by the Centers for Disease Control and Prevention and should not be construed to represent any agency determination policy.

